

Research on the Relation between Investment in Industrial Pollution Control and Economic Growth in Xinjiang

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Abstract

This paper analyzes the investment efficiency of the industrial pollution control of Xinjiang (2001-2013) by using DEA models. The results show that the efficiency of the whole industrial pollution control investment in Xinjiang is relatively low, and the investment DEA is not effective for industrial pollution and environment governance. Industrial pollution control investment efficiency level is low. This is mainly caused by the non-effectiveness of the pure technical efficiency prior to 2010 and the non-effectiveness of post-2010 scale efficiency. It means that the industrial pollution control investment and output structure prior to 2010 is irrational and the post-2010 scale efficiency is decreasing. Finally, aiming at the investment efficiency level of the industrial pollution control in Xinjiang, the paper puts forward to some countermeasures and suggestions.

Keywords

Industrial Pollution; Economic Development; Xinjiang; DEA Model

Introduction

Since the reform and opening up of Xinjiang Uygur Autonomous Region, the economy of the region has achieved a rapid growth, and the people's living standards have improved significantly. But the ecological environment foundation in Xinjiang is weak. In recent years, with the acceleration of the process of industrialization, in order to control the environment pollution and improve the ecological environment, Xinjiang needs to invest a lot of money. However, it depends on the environmental pollution control investment. The environmental governance investment is a very important link between the environmental problems and the economic development. The relationship between the environmental protection and the economic growth must be considered. The environmental governance investment is an important means to promote the coordinated development of economic growth and environmental governance.

In recent years, some scholars have carried out researches on the relationship between the economic growth and the environmental governance investment. For example, in 2006, Bao Qun et alii[1] made an investigation on China's panel data from 1996 to 2002 and they believed that the inverted U-shaped curve largely depends on pollution index and the method of selection. In 2009, Su Jie[2] analyzed and researched the national data by using the cointegration analysis method and her research results showed that there exists a long-term stable equilibrium relationship between the environmental governance investment and the GDP, and a reasonable increase in environmental governance investment does not affect the development of the economy of our country adversely. On the contrary, the investment can increase the economic benefit and the national income growth. The research on industrial pollution control investment mainly focused on the relationship between the industrial pollution emissions and the pollution control investment through the establishment of model or mechanism to explore the governance efficiency and make relevant investment and management strategies. In 2007, Fan Wenhui[3] carried out a study on China's existing situation and management strategies of the industrial solid waste. In 2010, Wu Shuli[4] studied the differences among the investment efficiencies in waste gas treatment and its influence factors. In 2015, Chen Shihong [5], based on the panel data of 10 provinces and cities, analyzed China's industrial pollution control investment and economic growth.

Xinjiang Industrial Pollution Control Investment

The total industrial pollution control investment in Xinjiang is increasing at an alarming rate. In 2001, it was 0.302 billion yuan, and it increased to 5.479 billion yuan in 2013. It has increased by 18.1 times.

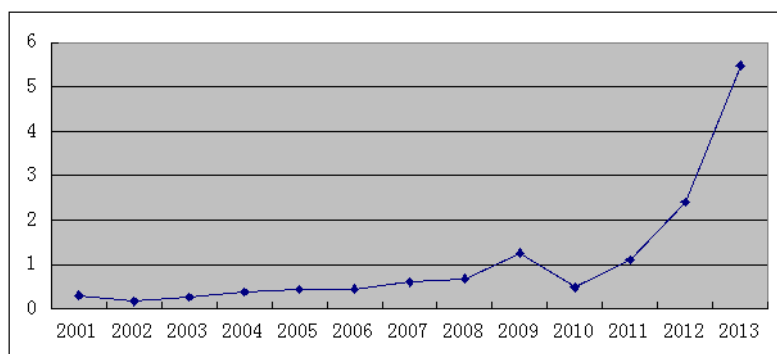


FIG.1 XINJIANG INDUSTRIAL POLLUTION CONTROL INVESTMENT (UNIT: RMB BILLION YUAN)

Figure 1 shows the growth rate of total industrial pollution control investment in Xinjiang is rapid. In 2011, the region's industrial pollution control significantly accelerated. In that year, 65 industrial wastewater treatment projects were carried out. The newly-increased industrial waste water processing capacity was 60.41million tons / day. 84 industrial waste gas treatment projects were started and 83 of the projects had been completed. The newly-increased industrial waste gas treatment capacity was 6.44 million standard cubic meters / hour. In 2012, 91 industrial wastewater treatment projects were started in the region and the newly-increased industrial wastewater treatment capacity was 1.67million tons / day; 131 industrial waste treatment projects were started and the newly-increased industrial waste gas processing capacity was 2.13million cubic meters / hour; the produced general industrial solid waste amount was 72.52million tons, the comprehensively utilized amount was 40.71 million tons, the processed amount was 4.85million tons and the stored amount was 26.95million tons. In 2013, 45 industrial wastewater treatment projects were started and the newly-increased industrial wastewater treatment capacity was 0.18million tons / day; 189 industrial waste treatment projects were started and the newly-increased industrial waste gas treatment capacity was 838.56 million standard cubic meters / hour.

Empirical Analysis

Research Method

Data envelopment analysis (DEA) is a new field of interdisciplinary research, first proposed in 1978 by the operational research experts A. Charnes, W.W.Cooper and E.Rhodes. Therefore, the first DEA model was named CCR model (abbreviated as C2R model) [6]. DEA method is a kind of important non parametric method, which can be used to measure the efficiency of the production decision-making unit (DMU) with multiple inputs and multiple outputs. The principle of DEA method is to estimate the production frontier problem by keeping the amount of inputs and outputs of decision making units and using a relevant mathematical programming method. The weights of the input and output variables in the evaluation process are obtained by solving the mathematical programming problems. The DEA method avoids the specific input and output expressions, excludes some subjective factors and has strong objectivity [7]. Therefore, the DEA method is an effective tool in dealing with the complex problem with multiple inputs and multiple outputs.

There are two commonly-used DEA models, C2R model and C2GS2 model. C2R model is to measure the technical efficiency of the decision-making unit, that is, to evaluate the comprehensive effectiveness of a system based on the assumption that the scale of the decision making unit is fixed [8]. C2GS2 model, based on the assumption that the returns to scale of decision making units are variable and the mixture of scale efficiency and technical efficiency has been excluded, divides the technical efficiency into the pure technical efficiency and the scale efficiency. The pure technical efficiency measures the effectiveness of the input resources configuration and the scale efficiency measure indicates the degree of the non-effective production [9]. When the C2R model is used to estimate the effectiveness of the decision making unit, C2GS2, DEA can determine whether the non-effective decision making unit of DEA is caused by the technical non-effectiveness or the scale non-effectiveness. The C2GS2 model consists of the

input-oriented model and the output-oriented model. The former seeks the minimum input while the output remains the same, and the latter seeks the largest output while the input remains the same. For regional environmental protection, the investment in pollution control is relatively easy to control, so this paper chooses the investment oriented model. Assuming that there are j decision making units (DMU), the DMUj input and output variables are [10]:

$$X_j = (X_{1j}, X_{2j}, \dots, X_{mj})^T$$

$$Y_j = (Y_{1j}, Y_{2j}, \dots, Y_{nj})^T \quad j=1, 2, \dots, n$$

In the input oriented C2GS2 model, θ stands for the efficiency evaluation index of each DMUj, which satisfies the following formula [7]:

$$\left\{ \begin{array}{l} \theta^0 = \min \sigma \\ \text{s.t.} \sum_{j=1}^n \lambda_j X_j + s^- = \sigma X_0 \\ \sum_{j=1}^n \lambda_j Y_j - s^+ = Y_0 \\ \sum_{j=1}^n \lambda_j = 1 \end{array} \right.$$

In the formula, $\lambda_j \geq 0$; s^- , s^+ are the introduced slack variables, $s^- \geq 0$, $s^+ \geq 0$; $j=1, 2, \dots, n$.

DEA analysis is used to evaluate the efficiency of industrial pollution control investment. The purpose of using the method is to get the optimal input and the optimal output when the industrial pollution control investment efficiency is optimal, trying to find out the factors that affect the investment efficiency of regional industrial pollution control, and find out the existing problems of environmental protection investment. It is essential to analyze the pure technical efficiency and the scale efficiency level in detail and to find the factors for improving the efficiencies from the aspects of the scale and technology.

Variable and Data Description

When comparing efficiencies by using DEA model, we need to input and output data of every decision unit. To be more specific, we have used the data from 2001 to 2013 as the sample space, the total industrial pollution control investment as the input indicator and the regional GDP as the output indicator. The data are from the Xinjiang Uygur Autonomous Region Economic Yearbook and the Xinjiang Uygur Autonomous Region Environment Bulletin.

Empirical Research Results and Analysis

First, on the average, the comprehensive technical efficiency of Xinjiang industrial pollution control investment is not high, only 0.532, at the bottom of the efficient production frontier. It has shown that Xinjiang environmental input-output has not reached the best level. On the one hand, it was caused by the poor use of the environmental protection funds; on the other hand, it was caused by the low level of the pollution control project operation efficiency. These may have made the comprehensive technical efficiency not high.

Second, the Xinjiang environmental protection investment scale efficiency is 0.781 which is in the stage of decreasing returns to scale and industrial pollution control investment scale should not be expanded too fast. Increase in input cannot bring greater output, and it will only cause more serious waste of resources.

Third, Xinjiang's pure technical efficiency value is 0.732, and it has shown that industrial pollution control investment did not achieve effective technique and Xinjiang needs to further improve the efficiency of industrial pollution control investment by adjusting the structure of environmental protection investment and improving the investment mode.

Fourth, it has been stipulated in the DEA model that the comprehensive technical efficiency = pure technical efficiency $\times$ scale efficiency, that is to say, the pure technical efficiency and the scale efficiency jointly determine the

comprehensive technical efficiency. After 2010, the pure technical efficiency of industrial pollution control value is 1, the Xinjiang industrial pollution control input-output structure is in line with the development of the industry but the scale efficiency showed a decreasing trend. It shows that Xinjiang's industrial pollution control investment scale of output did not reach the optimal state, the scale level also need to adjust.

Fifth, during the period from 2001-2013, through the analysis of Xinjiang industrial pollution control input-output efficiency, we can see some volatility. Before 2010, the pure technical efficiency performed irregular change; and the scale efficiency gradually increased, then decreased gradually. The ultimate expression of the comprehensive technical efficiency fluctuation degree is relatively large.

TABLE 1 LISTS THE DEA ANALYSIS RESULTS OF THE XINJIANG INDUSTRIAL POLLUTION CONTROL INVESTMENT IN 2001-2013

DMU	crste	vrste	scale	
2001	0.442	0.563	0.784	irs
2002	0.848	1.000	0.848	irs
2003	0.636	0.727	0.876	irs
2004	0.529	0.586	0.903	irs
2005	0.536	0.579	0.926	irs
2006	0.602	0.638	0.944	irs
2007	0.524	0.545	0.961	irs
2008	0.550	0.562	0.978	irs
2009	0.305	0.311	0.980	irs
2010	1.000	1.000	1.000	-
2011	0.534	1.00	0.534	drs
2012	0.279	1.000	0.279	drs
2013	0.136	1.000	0.136	drs
Mean	0.532	0.732	0.781	

(source: Data statistics of cnki.net)

(crste -comprehensive technical efficiency; vrste-pure technical efficiency ;scale- scale efficiency; irs-increase; drs-decrease; -: no change)

Conclusions

The paper has found that Xinjiang's investment in environmental protection is not in the efficient production frontier and its input and output have not reached the best level by carrying out the empirical analysis on Xinjiang's industrial pollution control input-output efficiency; during the 2001-2013, Xinjiang's industrial pollution control investment input-output efficiency was relatively low, and the comprehensive technical efficiency, the pure technical efficiency and the scale efficiency were 0.532, 0.732 and 0.781, respectively. These have indirectly proven that its contribution to economic growth has not been fully released.

According to the analysis of the input-output efficiency of the industrial pollution control in Xinjiang, we make the following recommendations:

First, strengthen the supervision over the use of industrial pollution control funds. Strengthen the tracking and management of funds and ensure that the funds are earmarked. As for the investment and construction of environmental protection projects, a professional feasibility study procedure should be strictly carried out. As for the construction of environmental protection facilities, the legal person responsibility system should be actively promoted. As for the environmental protection construction projects, the economic accounting mechanism of input and output should be introduced. As for the operation of environmental protection funds, the market mechanism should be introduced.

Second, improve the technical content of industrial pollution protection facilities. On the one hand, increase the investment in the industrial pollution protection technology and equipment development research and develop the environmentally friendly and practical technology and equipment suitable for regional economic development level. On the other hand, use tax concessions, tax breaks and other policy instruments to encourage enterprises to adopt environmental protection facilities with high technical content and good pollution prevention effects.

Third, adjust measures to local conditions and reduce blindness in investment. With the basis of the actual situation, avoid the waste of resources caused by unreasonable investment to ensure the long-term stability of the economy.

Fourth, pay attention to the long-term investment in pollution control and improve the economic benefits [5]. Because the short-term investment cannot make the economy grow, policy makers are decreasing the investment and this will reduce the reasonability of the investment in environmental governance. Therefore, the resources will not be allocated reasonably and it will reduce the long-term economic benefits and hinder the economic growth. In order to accurately locate the dividing point between the long-term investment and the short-term investment, policy makers must first fully understand and analyze the environmental factors within its jurisdiction, and then compare various factors in different areas and find the differences. Then they can formulate the early stage investment plans. After the plans are implemented, if there is no economic growth, they need to further analyze the internal and external factors and reduce the influence caused by the fluctuation and then modify the investment plan. After the modified plans are implemented, if economic growth occurs, they should keep investment amount, conduct some field survey to find the imbalance of the economic growth and solve the problem by improving the investment plans.

Fifth, it is necessary to improve environmental management via a suite of mechanisms that have the capacity for adaptation. We can move closer to achieve this goal through an overarching focus, including reformed and new law, adaptive management and adaptive governance, scenario planning, and leading indicators [11].

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